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BATTLES AND RAINFALL

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"DO battles cause heavy rains?" This question is being frequently asked by many who ordinarily are not disposed to readily accept the view that such a relation exists. Their skepticism has been somewhat shaken by the fact that battles probably the noisiest and bloodiest in history are in progress and coincidently heavy rainfalls have occurred near the battle territory and elsewhere.

The explanation which first suggests itself is that concussion due to cannonading has shaken down the raindrops. But there is no physical process known that directly connects rainfall and concussion as effect and cause and physicists unanimously agree that such a relation seems improbable. The first definite objection is that the air and water-vapor are not themselves transported by an explosion or any violent agitation like that due to gunfire. There is no transference of the medium itself any more than in the case of a sound wave. Waves of compression and rarefaction are in the nature of a progressive pushing and pulling, each molecule pushing its neighbor a short distance forward and then pulling it back. To make it still more plain, the air disturbance would be like those compressional waves in the earth's crust which every earthquake starts and which are recorded on seismographs.

The most violent explosion in air, therefore, would not remove any appreciable volume of air and vapor from one locality to another, while it would cause a pressure wave, and as in the case of great volcanic eruptions like Krakatoa, Mount Pelée and Katmai, a wave of sufficient intensity to be noted at observatories around the world. Such a wave encircles the globe in a few hours, and so far as we know has no effect in causing rain. But, on the other hand, it is true that in all great volcanic eruptions large quantities of dust particles (dust is the general name for all nuclei in the air) are injected into the higher air currents and carried from place to place. These do play a part in facilitating condensation and consequent precipitation. Krakatoa dust encircled the world in fifteen days and eventually probably caused excess rain in some localities. In this indirect way, rather than through concussion, it is conceivable that rain and explosions may be connected. But a volcanic eruption far exceeds in violence gunfire, even that of the greatest battles in modern warfare, and there is a vast difference between the gases generated and other output. The eruptions at Katmai, Taal, Asama Yama, Bandai San, Tarawera, Mount Pelée, the Soufrière of St. Vincent, Krakatoa, and even little Lassen, emitted enormous volumes of gas, fine ash and coarser matter. At Katmai, for example, the output was so great that the deposit at Kadiak 121 kilometers distant (75 miles) amounted to 35 centimeters (14 inches) of fine granules of sand, orange and yellow dust and pumice. Again, the intensities of the air shock, if we may so express it, are very different in eruptions and battles. Tornadic inrushes occur near the volcano and for some distance; while the wind rush of the largest gun when fired is hardly different from that of a passing train. A crude comparison of these relative intensities may be gleaned from a note made by Omori, the foremost seismologist of Japan, to the effect that during the Asama Yama eruption (December 7, 1909), there were marked pressure changes on nearly all the barographs in Japan and to a distance of 160 kilometers (100 miles), while in the city of Tokio, the daily noon gun fired close to the Central Meteorological Office never affects the instruments there. At Blue Hill Observatory, we have never been able to detect changes due to the firing of the big coast guns, or those of the fleet when manœuvring.

It, therefore, seems but fair to conclude that to cause rain, gunfire would have to be on a vastly greater scale than is at present the case. And, as for the attempts which have been made to produce rain by bombarding the clouds, it is enough to say that the claims and statements made by the experimenters, or shall we call them exploiters, are not supported by the facts.

Some years ago at Santa Barbara, during a prolonged dry spell, a meeting of the citizens was called to consider an offer from a temporary resident, a Michigan millionaire, to furnish all explosives needed to produce rain. This gentleman claimed to have successfully caused rain by these means on his ranch in Texas, during cloudy, threatening weather. While the meeting was in progress, rain began to fall and there was no further interest in explosives. This incident is referred to here because if the meeting had been held a day or two earlier, and the proposal accepted and the firing begun, it would have been extremely difficult to convince the people of that section that the rain was not directly connected with the firing. Men's ideas of the nature of the atmosphere are still very vague, and with this indefiniteness goes a corresponding readiness to draw conclusions from insufficient data. Sir William Ramsay has pointed out somewhere that the discovery of the true nature of air was held back for years because of erroneous ideas regarding combustion.

We may then dismiss the attempts of the American rain-makers and also the hail-shooters in Europe as inconclusive. There is no reliable evidence that such efforts have caused rain or any increase in the rainfall. Nor is it established that rain follows heavy battles and excessive firing. Records properly assembled disprove the existence of any positive relation between concussion and rainfall.

Still, it would be unwise to assert that our knowledge of the formation of rain and particularly the structure of a raindrop is such as to enable one to say that rain production is beyond the power of man. Furthermore, much that appeared to be fundamental and basic in physics, a few years ago, has now gone by the board or been so modified that the physicist is, to speak frankly, at sea regarding the structure of the atom and the nature of action at a distance. We know very little about the behavior of the large ions in air, also the small and intermediate ones, and their respective mobilities. In fact, we can only surmise as to the rôles played by these molecular clusters in actively assisting condensation and precipitation. We know that if the nuclei are filtered from air, condensation even with saturation is very slow. We also know that some of the nuclei are electrified but the great majority are not. There appears to be an intermediate state between gas and liquid. Through the investigations of Aitken, Wilson, Thomson, Barus, Langevin, Pollock and others, we picture the large ion as a nucleus on which water molecules are adsorbed (not absorbed), the extent depending upon the vapor pressure, and the whole being electrified by the small ion. We have been taught to believe that cloud formation is a physical process in which the effective factor is cooling. The cooling may be brought about by elevation, radiation, contact or conduction and mixture or convection, yet we may not shut our eyes to the possibility of electrical action in controlling the combination or agglomeration of minute particles. Just how this would take place or just how the raindrop and snowflake are built up is not yet known, nor how the process can be accelerated or retarded. Indeed if this were known, man would be nigh unto control of the rain, or at least have in his hands rudimentary means for compelling or preventing precipitation. Job's query which has remained so long unanswerable

> Who shall number the clouds, who shall stay the bottles of Heaven?

would be less of a poser. Stranger things have happened than that man should find a way to master the water vapor in the free air; and, for example, to dissipate the clouds and fogs. To make a commercial success of the process, however, would be another story.

Finally, it may well be asked if battles do not cause these abnormal rainfals, what does cause them; and why are some seasons so entirely unlike others? The best answer available at present, though by no means an assured explanation, is that the circulation of the lower air varies in different seasons; and this circulation is controlled by certain "low" and "high" pressure areas. The probability of this relation was first pointed out by a Frenchman of Scotch descent, M. Leon Teisserenc de Bort, the investigator who with his colleague, the late Professor Lawrence Rotch, did so much to add to our knowledge of the upper air; and in fact discovered the stratosphere. He was seeking for the explanation of certain cold spring months in the very region in which the war is now raging. Other meteorologists have carried the work further and we now think we know the cause of late springs and early springs on the Atlantic coast. There appears to be firm ground for asserting that when a marked hyperbar or excess of pressure overlies the northwest Atlantic, persisting for a week, a fortnight or even a month, the surface flow of air or winds will be mostly northeast and of moderate intensity. Such winds carry large volumes of water vapor and unless the land temperatures are high, the result is foggy, cloudy weather along the shore from Maine to New Jersey. This makes for a relatively late spring and cool summer, on the one hand, and a relatively warm winter, on the other. Similarly on the Pacific coast, it has been shown by the writer in his "Rainfall of California" that dry periods in the winter, which is normally a wet season, and wet periods in the early summer, which is normally a dry time, are directly associated with the location of certain hyperbars and infrabars. Just what are the determining causes in building up these centers of action the meteorologist can not yet say; and hence no accurate seasonal forecasts are possible. Weekly forecasts are indeed attempted by the Weather Bureaus of this and other countries; but, it may be frankly admitted, with only partial success. Still a beginning has been made and there is no doubt in the mind of the writer but that discoveries will be made and improvement follow.